

<sup>5</sup>This emission may be authorized for audio frequency shift keying and phase shift keying for digital data links on any frequency listed in § 87.263(a)(1), § 87.263(a)(3) or § 87.263(a)(5). 13K0A2D emission may be authorized on frequencies not used for voice communications. If the channel is used for voice communications, 13K0A9W emission may be authorized, provided the data is multiplexed on the voice carrier without derogating voice communications.

<sup>6</sup>Applicable to operational fixed stations in the bands 72.0–73.0 MHz and 75.4–76.0 MHz and to CAP stations using F3 on 143.900 MHz and 148.150 MHz.

<sup>7</sup>Applicable to operational fixed stations presently authorized in the band 73.0–74.6 MHz.

<sup>8</sup>The authorized bandwidth is equal to the necessary bandwidth for frequency or digitally modulated transmitters used in aeronautical telemetry and associated aeronautical telemetry or telecommand stations operating in the 1435–1535 MHz and 2310–2390 MHz bands. The necessary bandwidth must be computed in accordance with part 2 of this chapter.

<sup>9</sup>To be specified on license.

<sup>10</sup>H2B must be used by stations employing digital selective calling.

<sup>11</sup>For A1A, F1B and single sideband emissions, except H2B, the assigned frequency must be 1400 Hz above the carrier frequency.

<sup>12</sup>R3E, H3E, and J3E will be authorized only below 25000 kHz. Only H2B, J3E, J7B, and J9W are authorized, except that A3E and H3E may be used only on 3023 kHz and 5680 kHz for search and rescue operations.

<sup>13</sup>The letters “K, L, M, Q, V, W, and X” may also be used in place of the letter “P” for pulsed radars.

<sup>14</sup>Authorized for use at radiobeacon stations.

<sup>15</sup>Applicable only to transmitters of survival craft stations, emergency locator transmitter stations and emergency locator transmitter test stations approved after October 21, 1973.

<sup>16</sup>Authorized for use by aircraft earth stations. Lower values of necessary and authorized bandwidth are permitted.

<sup>17</sup>In the band 117.975–137 MHz, the Commission will not authorize any 8.33 kHz channel spaced transmissions or the use of their associated emission designator within the U.S. National Airspace System, except by avionics equipment manufacturers, and Flight Test Stations, which are required to perform installation and checkout of such radio systems prior to delivery to their customers for use outside U.S. controlled airspace. For transmitters certificated to tune to 8.33 kHz channel spacing as well as 25 kHz channel spacing, the authorized bandwidth is 8.33 kHz when tuned to an 8.33 kHz channel.

(b) For other emissions, an applicant must determine the emission designator by using part 2 of this chapter.

(c) A license to use radiotelephony includes the use of tone signals or signaling devices whose sole function is to establish or maintain voice communications.

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#### § 87.139 Emission limitations.

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the frequency bands 1435–1535 MHz and 2310–2390 MHz or digital modulation (G7D) for differential GPS, the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more

than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least  $43 + 10 \log_{10} pY$  dB.

(b) For aircraft station transmitters and for aeronautical station transmitters first installed before February 1, 1983, and using H2B, H3E, J3E, J7B or J9W, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 4.0 kHz, the attenuation must be at least 25 dB.

(2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 4.0 kHz, the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 4.0 kHz for aircraft station transmitters the attenuation must be at least 40 dB; and for aeronautical station transmitters the attenuation must be at least  $43 + 10 \log_{10} pY$  dB.

(c) For aircraft station transmitters first installed after February 1, 1983, and for aeronautical station transmitters in use after February 1, 1983, and using H2B, H3E, J3E, J7B or J9W, the peak envelope power of any emissions

must be attenuated below the peak envelope power of the transmitter (pX) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 30 dB.

(2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 38 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 3.0 kHz for aircraft transmitters the attenuation must be at least 43 dB. For aeronautical station transmitters with transmitter power up to and including 50 watts the attenuation must be at least  $43 + 10 \log_{10} pX$  dB and with transmitter power more than 50 watts the attenuation must be at least 60 dB.

(d) Except for telemetry in the 1435–1535 MHz band, when the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth for aircraft stations above 30 MHz and all ground stations the attenuation must be at least  $43 + 10 \log_{10} pY$  dB.

(e) When using frequency modulation or digital modulation for telemetry or telecommand in the 1435–1535 MHz and 2310–2390 MHz frequency bands with an authorized bandwidth equal to or less than 1 MHz the emissions must be attenuated as follows:

(1) On any frequency removed from the assigned frequency by more than 100 percent of the authorized bandwidth up to and including 100 percent plus 0.5 MHz, the attenuation must be at least 60 dB, when measured in a 3.0 kHz bandwidth. This signal need not be attenuated more than 25 dB below 1 milliwatt.

(2) On any frequency removed from the assigned frequency by more than 100 percent of the authorized bandwidth plus 0.5 MHz, the attenuation must be at least  $55 + 10 \log_{10} pY$  dB when measured in a 3.0 kHz bandwidth.

(f) When using frequency modulation or digital modulation for telemetry or

telecommand in the 1435–1535 MHz or 2310–2390 MHz frequency bands with an authorized bandwidth greater than 1 MHz, the emissions must be attenuated as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent of the authorized bandwidth plus 0.5 MHz up to and including 50 percent of the authorized bandwidth plus 1.0 MHz, the attenuation must be 60 dB, when measured in a 3.0 kHz bandwidth. The signal need not be attenuated more than 25 dB below 1 milliwatt.

(2) On any frequency removed from the assigned frequency by more than 50 percent of the authorized bandwidth plus 1.0 MHz, the attenuation must be at least  $55 + 10 \log_{10} pY$  dB, when measured in a 3.0 kHz bandwidth.

(g) The requirements of paragraphs (e) and (f) of this section apply to transmitters approved after January 1, 1977, and to all transmitters first installed after January 1, 1983.

(h) For ELTs operating on 121.500 MHz, 243.000 MHz and 406.0–406.1 MHz the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is moved from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent of the authorized bandwidth the attenuation must be at least 30 dB.

(i) In case of conflict with other provisions of § 87.139, the provisions of this paragraph shall govern for aircraft earth stations. When using G1D, G1E, or G1W emissions in the 1646.5–1660.5 MHz frequency band, the emissions must be attenuated as shown below.

(1) At rated output power, while transmitting a modulated single carrier, the composite spurious and noise output shall be attenuated by at least:

Frequency (MHz)	Attenuation (dB) <sup>1</sup>
0.01 to 1525 .....	–135 dB/4 kHz
1525 to 1559 .....	–203 dB/4 kHz
1559 to 1585 .....	–155 dB/MHz
1585 to 1605 .....	–143 dB/MHz
1605 to 1610 .....	–117 dB/MHz
1610 to 1610.6 .....	–95 dB/MHz
1610.6 to 1613.8 .....	–80 dBW/MHz <sup>2</sup>
1613.8 to 1614 .....	–95 dB/MHz

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Frequency (MHz)	Attenuation (dB) <sup>1</sup>
1614 to 1626.5 .....	– 70 dB/4 kHz
1626.5 to 1660 .....	– 70 dB/4 kHz <sup>2, 3, 4</sup>
1660 to 1670 .....	– 49.5 dBW/20 kHz <sup>2, 3, 4</sup>
1670 to 1735 .....	– 60 dB/4 kHz
1735 to 12000 .....	– 105 dB/4 kHz
12000 to 18000 .....	– 70 dB/4 kHz

<sup>1</sup> These values are expressed in dB referenced to the carrier for the bandwidth indicated, and relative to the maximum emission envelope level, except where the attenuation is shown in dBW, the attenuation is expressed in terms of absolute power referenced to the bandwidth indicated.

<sup>2</sup> Attenuation measured within the transmit band excludes the band  $\pm 35$  kHz of the carrier frequency.

<sup>3</sup> This level is not applicable for intermodulation products.

<sup>4</sup> The upper limit for the excess power for any narrow-band spurious emission (excluding intermodulation products within a 30 kHz measurement bandwidth) shall be 10 dB above the power limit in this table.

(2) The transmitter emission limit is a function of the modulation type and symbol rate (SR). Symbol Rate is expressed in symbols per second.

(3) While transmitting a single modulated signal at the rated output power of the transmitter, the emissions must be attenuated below the maximum emission level by at least:

Frequency Offset (normalized to SR)	Attenuation (dB)
$\pm 0.75 \times \text{SR}$ .....	0
$\pm 1.40 \times \text{SR}$ .....	20
$\pm 2.95 \times \text{SR}$ .....	40

Where:

SR = Symbol Rate,

SR =  $1 \times$  channel rate for BPSK,

SR =  $0.5 \times$  channel rate for QPSK.

The mask shall be defined by drawing straight lines through the above points.

(j) When using G7D for differential GPS in the 112–118 MHz band, the amount of power during transmission under all operating conditions when measured over a 25 kHz bandwidth centered on either of the second adjacent channels shall not exceed –25 dBm and shall decrease 5 dB per octave until –52 dBm.

(k) For VHF aeronautical stations and aircraft stations operating with G1D or G7D emissions:

(1) The amount of power measured across either first adjacent 25 kHz channel shall not exceed 2 dBm.

(2) For stations first installed before January 1, 2002, the amount of power measured across either second adjacent channel shall be less than –25 dBm and the power measured in any other adjacent 25 kHz channels shall

monotonically decrease at a rate of at least 5 dB per octave to a maximum value of –52 dBm. For stations first installed on or after January 1, 2002,

(i) The amount of power measured across either second adjacent 25 kHz channel shall be less than –28 dBm;

(ii) The amount of power measured across either fourth adjacent 25 kHz channel shall be less than –38 dBm; and

(iii) From thereon the power measured in any other adjacent 25 kHz channel shall monotonically decrease at a rate of at least 5 dB per octave to a maximum value of –53 dBm.

(3) The amount of power measured over a 16 kHz channel bandwidth centered on the first adjacent 25 kHz channel shall not exceed –18 dBm.

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### § 87.141 Modulation requirements.

(a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.

(b) A double sideband full carrier amplitude modulated radiotelephone transmitter with rated carrier power output exceeding 10 watts must be capable of automatically preventing modulation in excess of 100 percent.

(c) If any licensed radiotelephone transmitter causes harmful interference to any authorized radio service because of excessive modulation, the Commission will require the use of the transmitter to be discontinued until it is rendered capable of automatically preventing modulation in excess of 100 percent.

(d) Single sideband transmitters must be able to operate in the following modes:

Carrier mode	Level N(dB) of the carrier with respect to peak envelope power
Full carrier (H3E) .....	$O > N > -6$ .
Suppressed carrier (J3E) .....	Aircraft stations $N < -26 \geq$ Aeronautical stations $N < -40$ .